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The Treatment of Primary Tumors of the Femur With Chemotherapy (If Indicated), Resection and Reconstruction With an Endoprosthesis

R.P.H. VETH, MD, PhD, H.K.L. NIELSEN, MD, PhD, J. OLDHOFF, MD, PhD, H. SCHRAFFORDT KOOPS, MD, PhD, A. POSTMA, MD, W. KAMPS, MD, G.J. DEN HEETEN, MD, R.M. HARTEL, MD, F. VAN KRIEKEN, MSc, L.N.H. GÖEKEN, MD, AND J.W. OOSTERHUIS, MD, PhD

From the Departments of Orthopaedic Surgery (R.P.H.V., H.K.L.N.), Surgical Oncology (J.O., H.S.K.), Paediatric Oncology (A.P., W.K.), Pathology (J.W.O.), and Rehabilitation, University Hospital Groningen (L.N.H.G.); Groningen Paediatric Oncology Foundation (G.J.D.H.); Twente University of Technology, Enschede, the Netherlands (F.V.K.).

The treatment protocol of 15 patients with a primary tumor of the femur, including osteosarcoma, malignant fibrous histiocytoma and chondrosarcoma is presented. All patients had been selected for resection and reconstruction with an endoprosthesis. An endoprothesis was implanted in 12 patients.

The results of this type of treatment appear to be satisfactory. In eight osteosarcoma cases resection and reconstruction with an endoprosthesis combined with preoperative and postoperative chemotherapy, according to Rosen, were performed. Follow-up in all 15 patients, varying from 1.4 to 6.0 years, showed no evidence of disease in 12 patients. Three patients had died. Function of the involved leg was satisfactory in most cases.

The advantage and disadvantages of the use of an endoprosthesis are discussed as well as complications in this series of patients.

KEY WORDS: **primary tumors femur, chemotherapy, endoprosthesis**

INTRODUCTION

Limb-saving procedures in malignant tumors of the skeleton are becoming a more frequent challenge for many surgeons. Both allograft techniques and the use of biomedical materials are now under discussion in this respect. The effective use of chemotherapy [7,8] in the treatment of patients with a primary malignant tumor of the limb has changed the prognosis of the disease and, consequently, reconstructive procedures are becoming more and more frequent. Biological replacements have some definite advantages over the implantation of biomedical materials, in particular, when autogeneous bone graft can be used. When using allografts, the problem of immunological acceptance arises; both a humeral and a cell-mediated immune reaction are induced. Furthermore, the combination of chemotherapy and allo grafts should be avoided [4]. Delayed union as well as non-union of the graft can be a consequence of combining autografts, high dose methotrexate and adriamycin [1]. If one prefers prosthetic replacements in order to save the limb, the following criteria should be met: optimal mechanical fixation with or without cement and good mechanical properties of the prosthesis, including the artificial joint. In all methods of reconstruction, resection should be optimal. The postoperative function is clearly related to the amount of tissue resected.

In this paper the results of limb-saving procedures using prosthetic replacements in primary bone tumors are presented.

MATERIALS AND METHODS

In Table I, information concerning 15 patients with a primary malignancy of the femur is presented. Staging of the tumor was performed according to the criteria drawn up by Enneking et al [2]. All patients had been selected for resection and reconstruction with an endoprosthesis. After physical examination and laboratory studies, each patient was subjected to angiography of the

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Address reprint requests to R.P.H. Veth, MD, PhD, Department of Orthopaedic Surgery, University Hospital, P.O. Box 30.001 9700 RB, Groningen, The Netherlands.

TABLE I. Primary Tumors of the Femur, Selected for Prosthetic Replacement: Patients, Diagnosis, and Staging

No.	Sex	Age	Diagnosis	Stage	Localisation
1	F	46	Osteosarcoma	IIB	Proximal femur
2	M	12	Osteosarcoma	IIB	Distal femur
3	F	17	Osteosarcoma	IIA	Distal femur
4	F	16	Malignant fibrous histiocytoma	IIA	Distal femur
5	M	14	Osteosarcoma	IIA	Distal femur
6	M	10	Osteosarcoma	III	Distal femur
7	M	14	Osteosarcoma	IIB	Distal femur
8	M	11	Osteosarcoma	IIB	Distal femur
9	F	41	Chondrosarcoma	IIA	Distal femur
10	F	14	Osteosarcoma	IIB	Proximal femur
11	M	59	Chondrosarcoma	III	Middle shaft
12	F	19	Osteosarcoma	IIB	Distal femur
13	F	61	Chondrosarcoma	IIB	Proximal femur
14	F	14	Osteosarcoma	III	Distal femur
15	M	20	Osteosarcoma	III	Middle shaft

involved limb, total body scan and CT-scanning of the tumor and the lungs [5]; in many patients tomography and xerography of the tumor area were also performed.

In osteosarcoma (Fig. 1) and malignant fibrous histiocytoma, chemotherapy [6] was administered preoperatively using high-dose methotrexate, followed by citrovorum factor rescue, vincristine, adriamycin, bleomycin, cyclofosfamide and actinomycin D. Cis-platinum was occasionally used. The duration of preoperative chemotherapy varied from 1 to 11 months. Postoperative chemotherapy in these cases mostly consisted of two to five cycles of the T10B or A protocol as described by Rosen [8].

In most cases of osteosarcoma of the femur, the reaction of the tumor to chemotherapy was evaluated by means of a needle biopsy. The Huvos [7] criteria were used in order to classify this reaction. At least three biopsies were taken in every patient. In chondrosarcoma, no radio or chemotherapy was prescribed.

The criteria for reconstruction in primary tumors of the femur were as follows:

1. Adequate resection of the tumor
2. Moderate soft-tissue extension without involvement of the neurovascular bundle
3. The absence of metastases, or metastases which responded well to treatment
4. Optimal local and general conditions for operation; the absence of infective foci
5. Good cooperation of the patient

Almost every patient had been screened for infective foci prior to major surgery. In all patients 1,000 mg of cefradine were administered intravenously one hour before the operation and continued for 48 hours, dosage 6 gm daily. Definitive surgery in all primary tumors started with a wide [2] excision. The level of resection, at least 7 cm proximal to the tumor, was established by combining information obtained from normal X-ray films, tomography and CT-scanning. Biopsy scars were excised en bloc together with the tumor and soft tissues.

Prosthetic custom-made replacements consisted mostly of a combination of some of the following designs:

Bicentric acetabular cup, noncemented hemi-femoral component, total femoral component, semi-constrained knee prosthesis (Fig. 2) and cemented tibial component. When closing the wound after implantation of the prosthesis, the mobility of the involved limb was tested frequently. The gluteal muscles were sutured to the tensor- and vastus-lateralis remnants in proximal and total femur endoprosthesis. In all other areas, adaptation of remaining muscles was only performed when the function of the prosthesis, including the patellofemoral joint, was guaranteed. Postoperatively most patients were treated in Amsterdam suspended traction (Fig. 3) for three weeks. In this system active and passive motion on the involved limb is provided, and stress rates of the hip abductors are reduced by using 20–30 degrees of abduction and 20 degrees of flexion. Suction drainage was continued for at least 48 hours. Active and passive exercises were started after 48 hours in most cases. After three weeks of Amsterdam suspended traction, gradual weightbearing was initiated using two crutches. Full weightbearing was allowed 12 weeks postoperatively. Patients were advised not to take part in sports, except swimming, and to use one crutch outside.

RESULTS

Table II shows the type of treatment and function of the extremity at follow-up in 15 patients with a primary

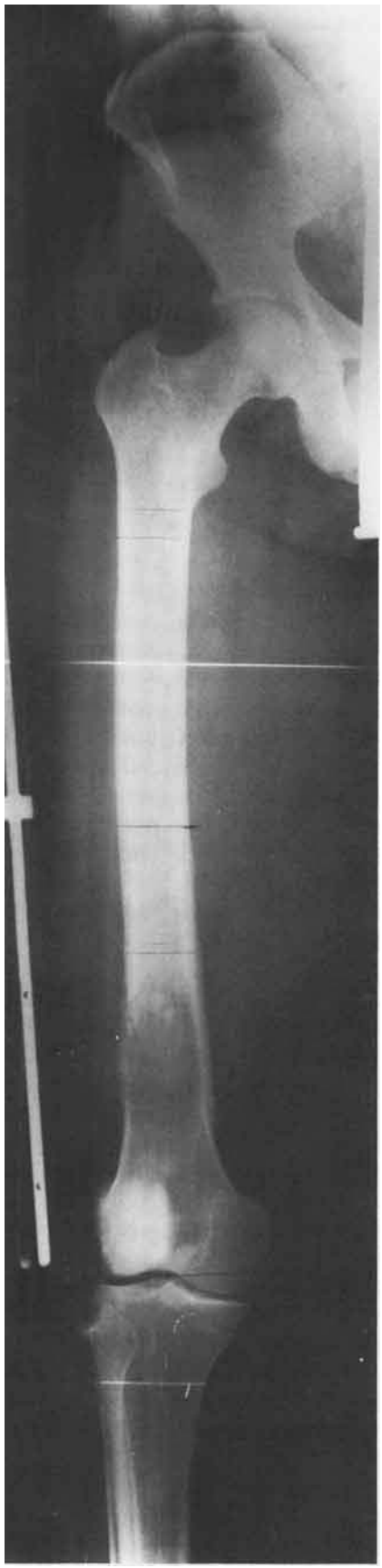

Fig. 1. Osteosarcoma of the femur.

tumor of the femur. In four patients (Cases 6, 11, 14, 15) a thoracotomy was performed prior to the operation of the involved limb, because of pulmonary metastases. In four patients with an osteosarcoma who underwent resection and reconstruction, the Huvos 3 and 4 classification at biopsy matched the definite sections (Cases 3, 5, 10, 15). In two patients (Cases 6, 7) a Huvos 4 classification was provided by biopsy; after resection the classification of the defiinite sections were 1 and 2 respectively. Three patients (Cases 12, 14, 15) underwent an amputation. Their Huvos classifications at biopsy were graded 3, 2 and 1; after amputation the following classifications were given: 3, 2, and 1 respectively. Two patients were not graded according to Huvos. Amputation instead of resection and reconstruction, thus, had to be performed in three patients. The main reason for this was unexpected tumor involvement of the neurovascular bundle. In three patients a leg length discrepancy was observed at follow-up: 7 cm (Case 2); 2.5 and 3.0 cm (Cases 6 and 8).

COMPLICATIONS

No evidence of superficial or deep wound infection nor loosening of the prosthesis was found in any of the patients. Two patients required prolonged suction drainage; 4 to 5 days instead of 2 days. In one patient (Case 9) a fracture of the knee component of the prosthesis was observed. One patient (Case 5) sustained a subtrochanteric bony fracture (Fig. 4) just proximal to a distal femoral prosthesis after a fall while riding his bicycle. Two patients (Cases 6 and 8) sustained an epiphyseal fracture outside the primary tumor area in the contralateral leg and distal radius twice after a minor trauma. In one patient (Case 11) a Bicentric® cup showed dislocation. Peroneal nerve palsy, not induced by chemotherapeutic agents, but resulting from surgery, was present in the same patient. All osteosarcoma patients had osteoporosis related to the chemotherapy. Many patients developed a peroneal palsy caused by vincristine.

Other complications due to chemotherapy were: encophalopathy, cardiomyopathy and stomatitis.

DISCUSSION

In several patients the initial biopsy had been carried out in another hospital. The biopsy sometimes interfered with the definitive surgical procedure, which necessitated a less than optimal approach. Analysis of the Huvos grading in this small series of patients with osteosarcoma of the femur shows that two patients whose specimens were graded 4 at biopsy and 1 and 2 at final operation, had no evidence of disease at follow-up. Two patients who finally underwent an amputation showed a Huvos grading 1 and 2 both at biopsy and at the time of operation. Both patients had died at follow-up. The remaining 5 patients who were graded 3 and 4 at both sections are

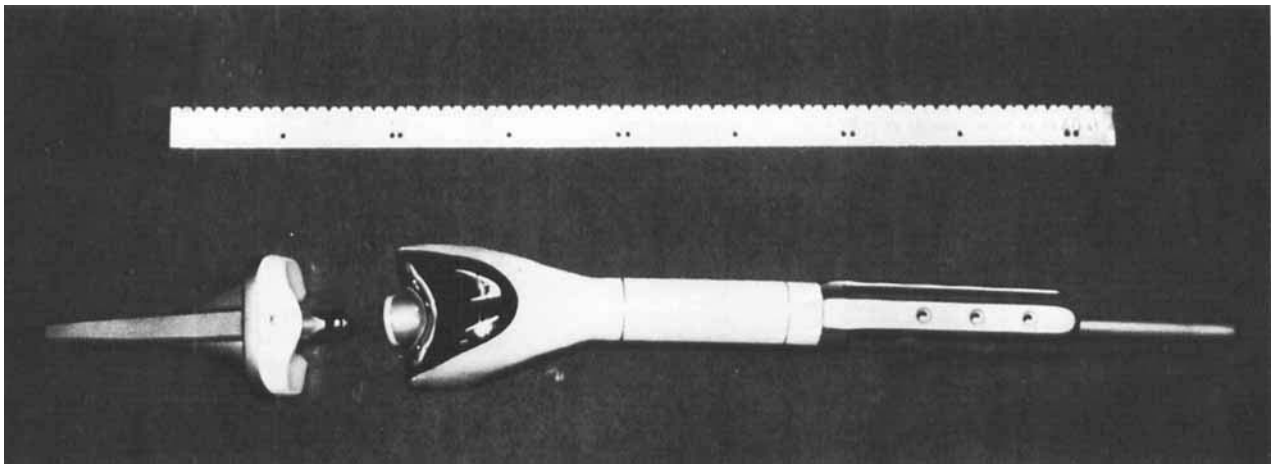

Fig. 2. Distal femoral prosthesis including flanges and axial rotating Endo ® knee prosthesis.

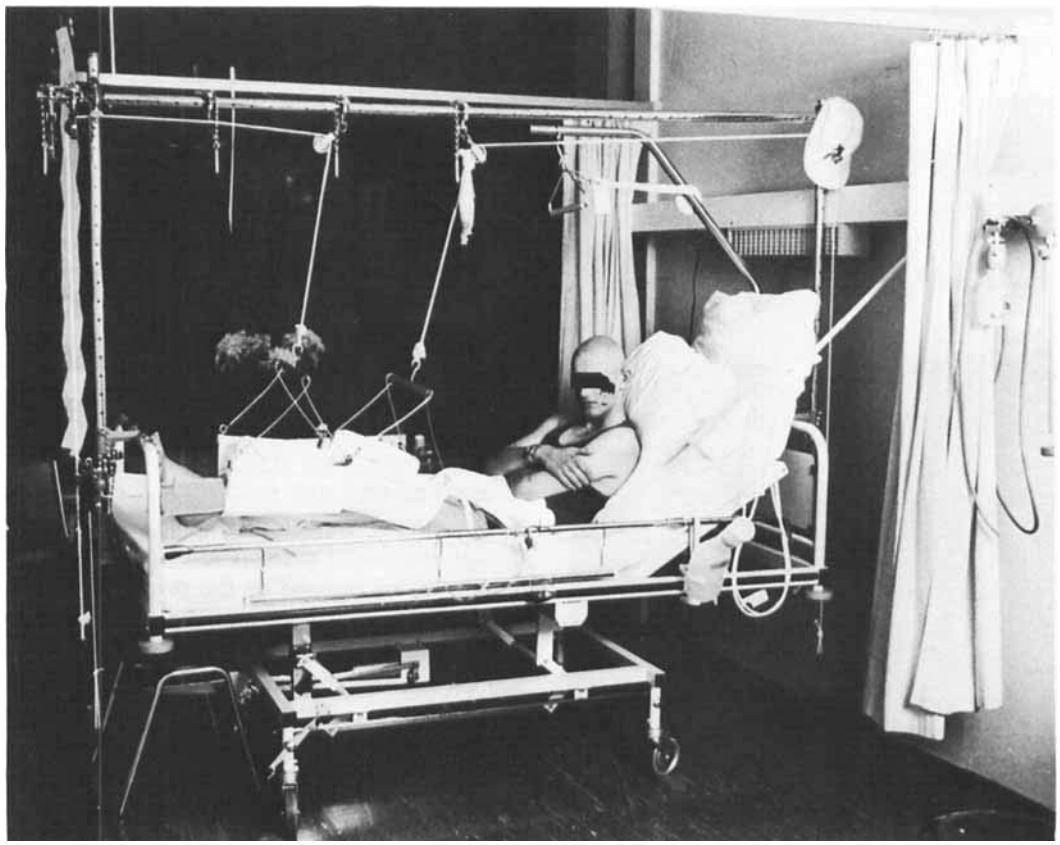

Fig. 3. Patient in Amsterdam suspended traction.

TABLE II. Primary Tumors of the Femur Treatment, Function and Complications at Follow-up

No.	Chemotherapy	Amputation/bone resection (%)	Prosthesis	Active knee and/or hip flexion	Complications	Follow-up in years
1	+	Wide (51.9)	Proximal femur	270	None	6.0 Ned[a]
2	+	Wide (100.0)	Proximal femur	140	None	6.0 Ned
3	+	Radical (100.0)	Total femur	115	None	5.3 Ned
4	+	Wide (100.0)	Total femur	140	None	4.5 Ned
5	+	Wide (49.0)	Distal femur	160	Fracture of bone	4.0 Ned
6	+	Wide (50.0)	Distal femur	125	Fracture of bone	2.8 Ned
7	+	Wide (51.0)	Distal femur	240	None	2.2 Ned
8	+	Wide (47.7)	Distal femur	280	Fracture of bone	2.3 Ned
9	−	Wide (69.5)	Distal femur	180	Fracture of prosthesis	2.3 Ned
10	+	Wide (54.0)	Proximal femur	125	None	2.0 Ned
11	−	Wide (100.0)	Total femur	170	Cup dislocation peroneal palsy	1.4 Ned
12	+	Amp/wide (—)	—	135	None	3.3 Ned
13	−	Wide (100.0)	Total femur	220	[b]2 year postoperative	—
14	+	Amp/wide (—)	—	120	[b]0.5 year postoperative	—
15	+	Amp/wide (—)	—	130	[b]0.3 year postoperative	—

[a]No evidence of disease
[b]Died.

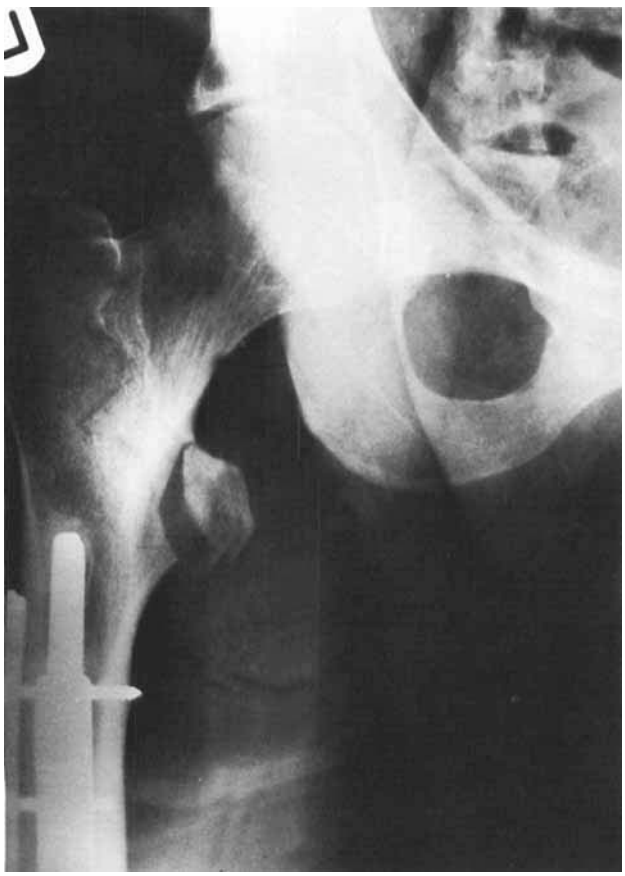

Fig. 4. Fracture of the proximal femur, superior to the prosthesis.

still alive, without evidence of disease. Our philosophy [9] regarding reconstruction in these patients is based on the principle that: cementless fixation should be preferred for the femoral component; a revision should be possible without a major risk of bony fractures; whenever possible the original acetabulum should be kept intact; and stress rates on the prosthesis–bone interface should be as low as possible.

This concept has guided us to a CO-Cr alloy design, using a smooth intramedullary stem combined with two flanges, one on the anterior side and one on the lateral side, in cases where a hemi-prosthesis was indicated. These flanges were fixed to the bone using bicortical screws laterally, and unicortical screws ventrally (Fig. 5). Soft-tissue contact to the femur was secured on the medial and dorsal sides. The contour of the shaft of the femur was transposed on the stem as much as possible. This is expected to be more physiological, diminishes reaming time and the risk for fractures, preserves endosteal circulation, facilitates the introduction of the stem into the intramedullary cavity and enlarges the contact area of the bone.

In proximal and total endoprosthesis a Bicentric (Howmedica, Limerick, Ireland) cup system was used for the hip. Only in cases with protrusio, osteoarthritis or a bad fit a cup would have been cemented in. For the knee component a Spherocentric® (Howmedica) prosthesis was used until 1982. From then on an axial rotating Endo® (Waldemar Link, Hamburg, FRG) knee prosthesis was preferred. The distal part of the knee component was

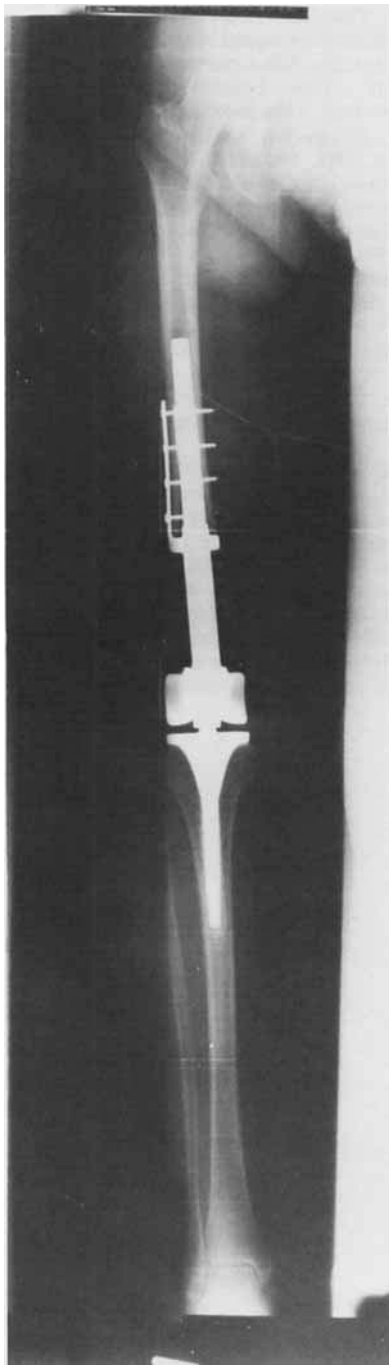

Fig. 5. X-ray film of a distal femoral prosthesis.

always cemented into the tibia. In children in whom a total femur endoprosthesis was indicated, the length of the prosthesis was calculated according to the X-rays and enlarged by 1 to 2 cm. This procedure was carried out in anticipation of further growth.

Muscle transfers were seldom necessary. In one case (number 6) a biceps femoris to the quadriceps remnants was performed after major resection of soft tissue and partial patellectomy. In this patient immobilisation of the involved extremity was advised for three weeks, followed by mobilsation in Amsterdam suspended traction. In one patient (Case 2) a patellectomy had to be performed because of technical problems regarding the prosthesis. Postoperatively, immobilisation was advised for three weeks, followed by Amsterdam suspended traction. Apparently, major resection of soft tissues, partial and total patellectomy, as well as prolonged immobilisation contributed to a poor functional result in these patients. The length discrepancy in young patients appeared to be inevitable. In order to prevent the occurrence of this disadvantage, we are studying the use of a lengthening prosthesis. A noninvasive lengthening should be most appropriate because of the diminished risk for infection. In three patients a fracture had to be treated. One fracture occurred just proximal to a distal femoral prosthesis after major trauma. Two boys, aged 10 and 11 years (Cases 6 and 8), each sustained two epiphyseal fractures in a noninvolved limb due to a minor trauma. In our opinion, a relationship between these fractures and the long-term use of chemotherapeutic agents should be considered [10]. Only one dislocation of a Bicentric cup had to be treated. Complications, related to surgery and the prosthesis, were treated in the following ways: patients 5, 6, and 8 had bony fractures. All fractures were treated conservatively and healed well. In Case 9 a partial revision of the prosthesis was performed. In Case 11 the Bicentric cup was removed and a Müller (Protek, Bear) acetabular cup was cemented in.

It became evident at follow-up that all patients who underwent a resection and reconstruction were satisfied by the result of the operation. In part, this is proved by the fact that some of these patients participate in sports, which are not recommended by our team.

In order to make a more sound evaluation of the results of this kind of treatment, the Enneking [3] criteria, which were proposed in Vienna in 1983, were used. According to these criteria, the following categories can be used to rate each case: Excellent: 0 (no case), Good: 4 (Cases 1, 5, 7, 8), Fair: 7 (Cases 2, 3, 4, 6, 10, 11, 12); Poor: 0 (no cases).

In conclusion, taking into account a limited follow-up period, we have learned from a modest number of patients that: in osteosarcoma and malignant fibrous histiocytoma the goal of a combined treatment protocol with chemotherapy, resection and endoprosthesis can be achieved, including adequate treatment of the tumor and salvage of the limb without local recurrence or metastases. In these patients function of the involved extremity can be satisfactory if one combines the proper selection

criteria with the optimal physiological design of the prosthesis. Finally, well-balanced postoperative treatment is obligatory.

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